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From the Proceedings of the Boston Society of Natural History, Vol. XVII, pp. 15-33, May 20, 1874.

GENETIC RELATIONS

OF THE

ANGULATIDÆ.

By A. HYATT.

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Oct. 7, 1876.

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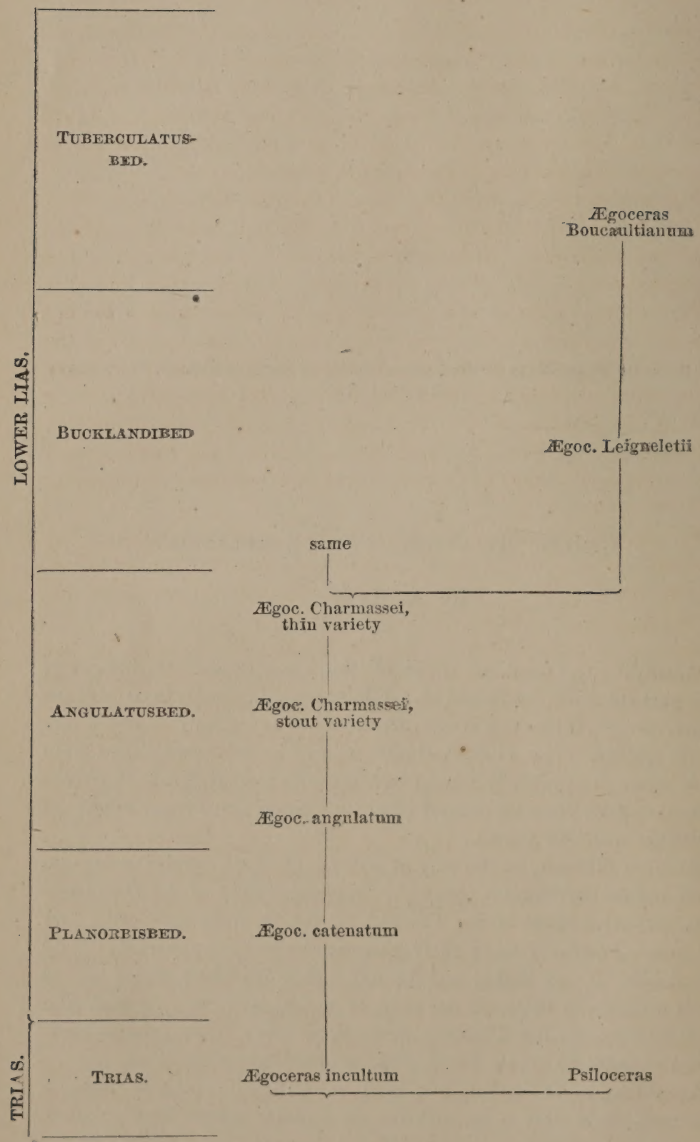
Genetic Relations of the Angulatidæ.

By A. Hyatt.

According to Oppel, all three of the lower species of this group, and perhaps four, are identical. I have not, however, been able to satisfy myself that even *Amm. Moreanus* of D'Orbigny is not a separate species. The characteristics in which the forms differ from each other are precisely similar to those which distinguish *Ægoceras Boucaultianum* from its nearest ally, and this is considered worthy of a distinct name by Oppel.

Another difficulty in the way of joining all these species under one name is that they form a group precisely equivalent to the Discoceratidæ, or to the whole of the Falcifiri, so far as their involution and the general parallelism of their characteristics is concerned. They are simply a very highly accelerated series, in which there are as great differences between the extreme forms, as there is between the extreme forms of the Discoceratidæ or of many other groups, composed of more numerous forms with less abrupt modifications.

According to D'Orbigny his *Amm. catenatus*, of which we have a specimen from the neighborhood of Semur, occurs locally below


LOWER LIAS.
TRIAS.
TUBERCULATUS-BED.
BUCKLANDIBED
ANGULATUSBED.
PLANORBISBED.
TRIAS.
Ægoceras Boucaultianum
Ægoc. Leigneletii
same
Ægoc. Charmassei, thin variety
Ægoc. Charmassei, stout variety
Ægoc. angulatum
Ægoc. catenatum
Ægoceras incultum
Psiloceras

Ægoceras Charmassei and *Leigneletii*, and according to Oppel, all these forms are in the "Angulatusbett," succeeded in the "Tuberculatusbett," by *Ægoceras Boucaultianum*. If there is really any such regularity of succession, and from the collection at Semur it would seem to be even more regular than Oppel supposed, it would accord admirably with what has been observed in other groups.

Not only does the involution greatly increase in each succeeding species, but the septa become more complicated in outline, and the adult characteristics of the pilæ [1] and form are repeated at earlier and earlier stages in each species. This may be seen by the following descriptions. The same law governs also the inheritance of the old age characteristics of the individual. Thus *Boucaultianus* has the old age characteristics sooner developed in its growth than any other form, and occurs latest in time, thus showing that the acceleration, or quicker reproduction of the characteristics, extends to the whole life, affecting even the period at which old age begins. The size increases in each successive form to *Leigneletii*, and then decreases considerably in *Boucaultianus*.

One specimen from Semur is labelled *Ammonites Boucaultianus*, but evidently belongs to *Leigneletii*. This shows that in extreme old age the abdomen becomes perfectly sharp and smooth; the pilæ are obsolescing, not reaching quite to the edge of the abdomen.

In Prof. Fraas' collection, associated with *P. planorbis* in the Planorbisbed, is a specimen of *Ægoceras angulatum* var. *catenatum*, and as this is the first appearance of *Ægoceras angulatum*, it is interesting to notice that it is less involute, more discoidal, and the whorl is more involute in aspect, or more like *P. planorbis* in its proportions than the members of the same group, which follow in the Angulatusbed.

It seems to me, therefore, that both by its geological position and characteristics it deserves to retain the separate appellation of *Ægoceras catenatum*. The developmental histories of both *catenatus* and *angulatus*, seem at first sight to contradict the supposition that they can be traced to *P. planorbis*, since the resemblances of the adults disappear and the differences become more and more prominent as the shells are traced backward to their younger stages of growth.

In the collection at Semur there are three specimens in the Planorbisbed under the name of *catenatus*. They are not large, but one exhibits obsolescing ribs and a smooth abdomen at the diameter of

[1] Pilæ is used as synonymous with ribs.

52 mm. D'Orbigny's types agree with this identification. One specimen from the lower part of the same zone with *Liassicus* is named *moreanus*, and may be said to agree with D'Orbigny's figure.[1] This is simply a variety identical with *colubratus* Zeit., growing to a larger size than *catenatus*.

At the diameter of 168 mm. in this specimen, the pilæ crossed the abdomen, showing that old age had set in. That this is sometimes an embryonic feature retained throughout life is shown by another specimen, which at the diameter of 21 mm. has the ribs continued over the abdomen. The typical *angulatus* form occurs as in Germany, in the true Angulatusbed, above the *catenatus* and *moreanus* varieties. The stout form of *Charmassei* occurs at Semur in the same bed, but the more compressed and more involute form which passes into *Leigneletii* occurs in the *Scipionianus* zone, and also in the *Bucklandi* zone. In the latter it is associated with a very thin form which seems to be a transition to *Boucaultianus*, and is identical with *Charmassei* D'Orbigny figured in Pl. 92, figs. 1, 2. One of these, 375 mm. in diameter, had the pilæ quite prominent on the abdomen.

The true *Boucaultianus* occurs above the Bucklandibed, associated with *Birchii*.

Amm. subangularis Oppel, in the Munich Museum, from Kaltenthal, has young like *planorbis*, but the pilæ in one specimen cross the abdomen. Another from Filder has smooth abdomen until it is an inch in diameter, then the pilæ cross the abdomen. One from Hammerkhar seems to pass through this stage, and finally becomes channelled, as in *angulatus*. In old age the abdomen continues smooth, and the shell resembles the old stage of *Caloceras Johnstoni*. This is hardly an intermediate form, and does not confirm the evidence brought forward by Prof. Quenstedt, which is founded upon the occurrence of similar abnormal forms, though the conclusions of that sagacious author are in the main correct. It seems to me, indeed, to be merely a reversionary form of *planorbis* or *Johnstoni*.

Waagen's name Ægoceras is retained for this group on account of the resemblance of the extreme young of *angulatus* to the figure which he gives of the type of his genus, *Ægoceras Buonarotti* of the Muschelchalk. He and Mojsisovics concur in describing the extreme young of *Amm. incultum* as similar to *planorbis*. If this is really so, and *Palmai* and *planorbis*, etc., are as nearly related as they appear to be by

[1] The original in the Jardin des Plantes is a fragment. It is like the figure, but shows that the interior whorls have been almost wholly restored.

descriptions and figures, we have the means of tracing both Ægoceras and Psiloceras to a common stock. Therefore Quenstedt after all is in the main correct, though the point of separation for the two stocks, one the parent of the Arietidæ, and the other of the Angulatidæ, must be sought in the Trias and not in the Lias. The resemblances between the form and characteristics of the full-grown *Amm. incultum* and the young of *Ægoceras angulatum* during the stage in which the pilæ stretch across the abdomen, and the channel is still undeveloped, are numerous and convincing in this respect.

Ægoceras angulatum Waagen.

Amm. angulatus Sch., Die Petref., p. 70.

Amm. catenatus Sow., De la Beche Traite de Geol., p. 407, f. 67.

" " D'Orb., Ter. Jurass., Ceph., pl. 94.

Amm. colubratus Ziet., tab. 3, fig. 1.

Amm. angulatus depressus Quen., Die Ceph., p. 75, pl. 4, fig. 2.

Nothwithstanding Oppel's reunion of this species with *Charmassei* and *Leigneletii* of D'Orbigny, I cannot regard them as anything more than closely allied species, since they differ in the young, as well as in the adult and old age. The young *appear* to be smooth for about one and a half whorls, then lateral tubercles appear. These spread upon the sides into folds, which on the early part of the fourth, or last of the third whorl, rapidly become true depressed pilæ, and then begin to be continued across the abdomen with a very decided forward bend in the geniculæ, and an acute angle on the abdomen. The furrowing or lineal depression which obliterates the angle of intersection of the pilæ on the abdomen, is developed on the last half of the fourth whorl.

On the early part of the fourth whorl the shell has already the abdominal lobe somewhat deeper than the superior laterals, and these again very much deeper than the inferior laterals. The cells broad and rather shallow, the superior laterals being a trifle shallower than the inferior laterals, as in the Arietidæ.

On the first quarter of the fifth volution the bases of the superior and inferior lateral cells and the tops of the superior lateral lobes, have become trifid, or unequally divided, whilst those of the inferior lateral lobes and auxiliary cells are equally divided. The abdominal lobes are shorter than the superior laterals, though the cells maintain their old proportions.

In the full adult condition the characteristics of the septa differ considerably from the Arietidæ, but approximate to those of Psiloceras.

The minor lobes are more numerous, deeper, and pointed than in the Arietidæ, the minor cells being quite leaf-like, the abdominal lobe considerably shallower than the superior laterals, the inferior laterals very short, and the auxiliary lobes quite numerous and bending posteriorly at a considerable angle. The seventh whorl increases in size with great rapidity, the abdomen becoming narrower, the channel shallower, the pilæ more depressed, losing their prominent, somewhat abrupt, genicular bend, and on the abdomen becoming depressed to a level with the siphonal line.

The involution of this whorl is about two-fifths, and that of the ninth a trifle over one-half. The peculiar flattening of the sides and form of the adult whorl, and the amount of involution, are close approximations to the adult characteristics of *Amm. Charmassei*, but the septa are different and the young more robust; the pilæ are developed earlier and more rapidly, and the abdominal channel also. In some specimens, however, these last are not noticeable until quite a late period, the pilæ being continuous across the abdomen, as in *D. planicostum*, even on the sixth volution.

In the collections at the Stuttgart Museum are several very fine specimens of the old age of this species, and it is easy to distinguish it from *Charmassei*, by the narrowness of the whorls, and its more open umbilicus and discoidal aspect. One of the largest *angulatus* measures 495 mm., the last whorl 17 mm.; another measures 515 mm., and last whorl 18.5 mm.

In the Museum at Stuttgart, in the centre of a crushed specimen of the true *angulatus* from Kirchheim, the young was very clearly exposed. This had very smooth and round, though rather stout whorls. The pilæ appeared on the sides as faint folds, which are straight at first, then curve, reach the abdomen, and finally cross it with a forward inflection. These become very prominent and decided before the channel is formed, which finally cuts through the pilæ. This variety, however, is considerable, since in the adult of this specimen the channel is only partially developed, the pilæ being only about half cut through, though the specimen is about two and one-fourth inches in diameter. There is here a close likeness to some of the trias forms, but not to the true *Planorbis* which the young does not resemble at all.

In young specimens in Prof. Quenstedt's collection, and the Museum of Comparative Zoölogy, the same was observed. It often occurs also that after the character is developed, and the shell quite large,

the pilæ again join, but this is not so frequent as has been supposed. They more often remain separated until old age.

The early occurrence of this form in the Planorbisbed is established by repeated observations on the part of Profs. Quenstedt and Fraas in Wurtemburg. The separation of the pilæ is not uncommon in other groups, especially in Perisphinctes. The original of *Amm. angulatus* Sow., which I saw in the British Museum, is only a malformed *communis*.

Ægoceras Charmassei Hyatt.

Amm. Charmassei D'Orb., Terr. Jurass., Ceph., p. 296, pl. 91, 92.

Besides the characteristics mentioned in the description of *Ægoceras angulatus* the following may be added. On the sixth volution, the extremely gibbous form of the young begins to change. The whorl increases more rapidly, the abdomen is narrower, and the pilæ as in preceding species, with this exception. On this volution, or perhaps on the fifth, they become bifurcated, or else have intermediate short pilæ interspersed between the longer ones. The septa have remarkably large abdominal lobes, shallower than the superior laterals, but with a much more ragged outline. The siphonal cell is extraordinary in this respect. It is very large, and marked with several lateral minor lobes and cells. The remaining lobes and cells are much more complicated than in *angulatus*.

On the sixth volution the form of the whorl changes exactly as in *angulatus*. The envelopment of this whorl equals one-half of the side of the sixth, whereas in *angulatus* the envelopment does not equal this until it reaches the ninth volution. The envelopment at the same age in this species, that is on the ninth whorl, covers full two-thirds of the side of the eighth whorl. There is a form in Prof. Fraas' collection from Möhringen answering to the young of *Charmassei*, as figured by D'Orbigny, pl. 91, and another from Filder, which is precisely intermediate in its characteristics between this and the smoother, flatter variety figured on pl. 92. The oldest specimens in the possession of the Museum of Stuttgart measured 53 mm., and the last whorl 23 mm. *A. angulatum* parts with its pilæ and grows smooth much earlier apparently than *A. Charmassei*. Probably this occurs at about the same age, but the superior size of *Charmassei* makes it seem older when the old age characteristics begin to appear.

Ægoceras Leigneletii Hyatt.

Amm. Leigneletii D'Orb., Terr. Jurass., Ceph., p. 298, pl. 92.

Amm. angulatus compressus Quen., Die Ceph., p. 75.

The same class off acts divides this species from *Charmassei* that we used to show the differences between the latter and *angulatus* — namely that the young differ as well as the old in some specimens.

The differences are very great between the fifth whorl (about) of *Leigneletii*, and the same age in *Charmassei*. The tubercles are more prominent on the edge of the abdomen, the pilæ more depressed on the sides, and their terminations tubercular on the edge of the abdomen, which instead of being a broad, rounded space, is a flattened zone. The reduction of the abdomen of course occurs in all species of this group, but in other species, except *Boucaultianus*, it is found only during the senile stage.

A specimen of Boucault's Collection, labelled *Amm. Charmassei*, is probably the young of this species. If so, the young shell differs from *Charmassei* in having laterally compressed whorls, like those of its own adult, much finer pilæ, not so prominent and near the abdomen, bifurcating very regularly. The smooth lateral zones found on the fifth volution are not indicated on the fourth whorl in this specimen, and it resembles at this time in the form of the whorl, the pilæ and the abdominal channel, a much older stage of growth which occurs in *Charmassei*.

Amm. angulatus compressus of Quenstedt may also in part belong to *Charmassei*, but the two specimens from Museum Stuttgart are apparently of this species only. The development in one of these specimens covers about two-thirds of the sides of the eighth whorl, and about the same age the pilæ again cross the narrow abdomen, obliterating the siphonal depression or bare tract, and introducing a series of crenulations instead. This is a return to the young condition, and indicates the first degradational or old age period. Of course it is not intended by this to deny that there are no young which closely approximate to the young of *Charmassei*. On the contrary some specimens are apparently identical in all respects, except the greater flatness and the earlier period at which the involution appears to be shown. In fact the species are connected by numerous transitional forms with *Charmassei*.

Ægoceras Boucaultianum Hyatt.

Amm. Boucaultianus D'Orb., Terr. Jurass., Ceph., p. 294, pl. 90.

This remarkable species differs from *Leigneletii* in about the same manner that that species differs from *Ægoceras Charmassei*, in other words, it is more involute than *Leigneletii* at the same age; on about the seventh or eighth whorl, at least three-fourths of the sides are hidden. The pilæ are not so coarse as in that species, and the abdominal channel is obliterated at an earlier age, and succeeded by the crenulations caused by the pilæ. The septa differ considerably. The specimen examined was one of D'Orbigny's types. The same transitional forms which lead into *Leigneletii* also lead into other more compressed and more involute forms which are transitional to the true *Boucaultianus*. They differ from *Leigneletii* only in the suppression of the tuberculated pilæ, and a general tendency toward obsolescence of the pilæ on the sides.

Appendix to Communications on Reversions among Ammonites.

Proc., Vol. xiv, 1870, p. 22.

Microderoceras Birchii.

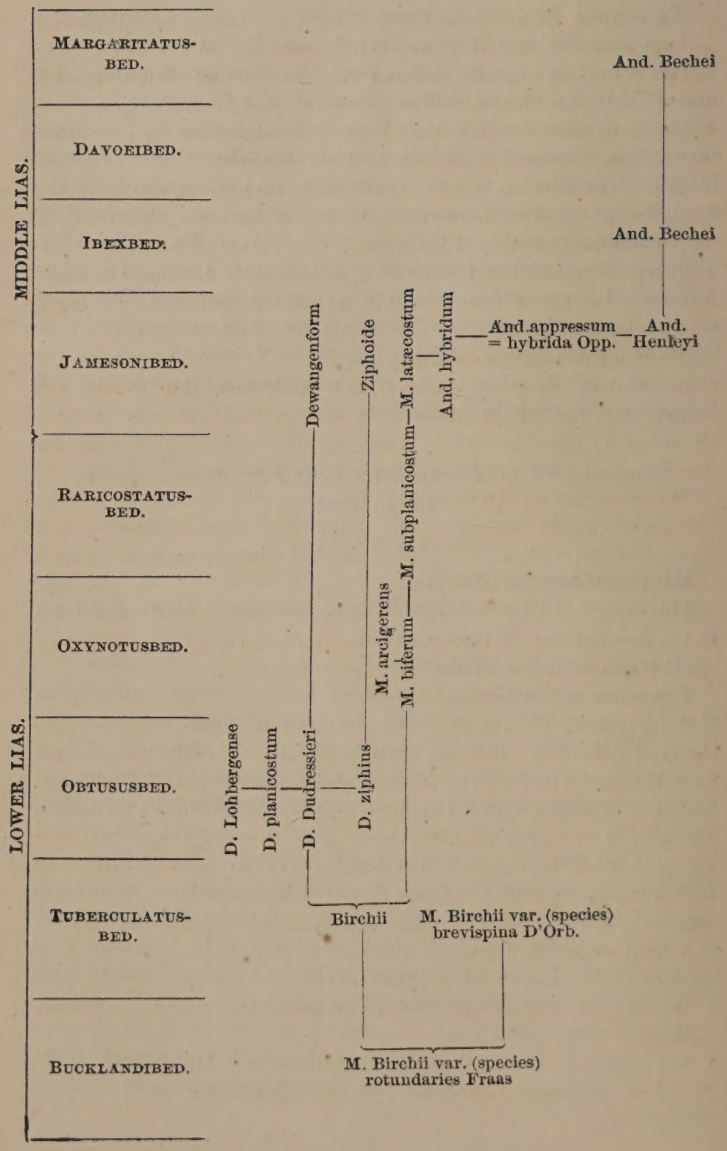
This occurs in the form named *Amm. rotundaries* by Fraas (MSS.) in the Arietenbank or Bucklandibed.

Microderoceras Hebertii.

This is not the Hebertii of Oppel, but a form intermediate between that figured by D'Orbigny under the name of *Amm. brevispina* and the typical *Birchii*. It is not found in the Middle, but in the Lower Lias Birchiibed at Semur. The confusion arises out of a false identification by Oppel from the supposed types in D'Orbigny's collection. The type is really a very rare form of *Birchii*, found only, so far as I know, in the Museums at Semur and Cambridge. The specimens in D'Orbigny's collection are forms of the single-spined group allied to *armatus*. They differ from the type described by D'Orbigny, and also from *Hebertii* of Oppel, which is identified in Germany, and appears in the Munich collection as a species allied to *Valdani*, with a keel, and all the characteristics of its group.

Microceras biferum.

The young of this species in some varieties is very similar to the young of *Birchii*, and confirms the views previously taken of their affinities.


MARGARITATUS-BED.
DAVOEIBED.
IBEXBED.
JAMESONIBED.
RARICOSTATUS-BED.
OXYNOTUSBED.
OBTUSUSBED.
TUBERCULATUS-BED.
BUCKLANDIBED.
MIDDLE LIAS.
LOWER LIAS.
And. Bechei
And. Bechei
And. appressum = hybrida Opp.
And. Henleyi
And. hybridum
M. latæcostum
M. subplanicostum
M. biferum
M. arcigerens
Ziphoide
Dewangenform
D. Lobbergense
D. planicostum
D. Dudressieri
D. ziphius
Birchii
M. Birchii var. (species) brevispina D'Orb.
M. Birchii var. (species) rotundaries Fraas

Amm. polymorphus mixtus Quenst. is not a synonym of this species, and my remarks are erroneous in this respect. In Quenstedt's collection there are several specimens with the Turrilete deformity, supposed to be identical with *Turr. Valdani* and *Coynarti*. They are, however, members of this species, and not equivalent to *Turr. Coynarti*, though perhaps equivalent to *Turr. Valdani*.

Turr. Coynarti is evidently a deformed specimen of *planicosta* and *Turrilites Boblayei*, a deformed specimen of *carusense*, according to D'Orbigny's collection. I have found also similar deformities in several other species, so that it is an unquestionable deformity to which species of the Lower Lias are more or less susceptible, as previously noticed by Quenstedt.

Microceras latæcostum.

Besides the varieties *sinuosum* and *maculatum*, this should also include *crescens*. It cannot readily be separated, either by its form or any of its characteristics. The original of Sowerby has only one row of spines until quite large, when it acquires two.

Microceras arcigerens.

This is the English representative of *Microceras biferum*, and in some specimens is not separable from that species, while in others it is not separable from *latæcosta*.

The young of all, and the adult stages of some specimens, are like the young and adult stages of *biferum*, while the adult of other specimens have the peculiar form and pilæ of *latæcosta*.

Deroceras Dudressieri.

In Quenstedt's collection are several remarkable forms of this species. One begins to show old age, or rather in that case a premature decay of parts begins to take place when the shell is only two inches in diameter. The tubercles and folds begin to show signs of decay in a perfectly normal way, even at this early age. Another specimen from Dewangen (Der Jura, p. 125) has young, with enormously large, truncated spinous casts, as in *armatum*. There are other young of this species which are identified as *planicosta* Sow.[1]

Deroceras ziphius.

Amm. armatus sparsinodus Quenstedt.

Quenstedt's magnificent series confirms the views previously printed.

[1] See also Der Jura, p. 97, *Capricornus nudus*.

Deroceras ziphoides.

Amm. ziphoides Quenst., Der Jura, p. 130, pl. 15, fig. 11.

This is really only a form of *ziphius* in the Lias, which has an accelerated mode of development, and has partly skipped the planicostan character of the abdomen. The pilæ still cross the abdomen, but have lost their broad planicostan aspect.

Deroceras planicostum.

Sowerby's specimens are mixed with *latæcosta* and *Dudressieri*. These hardly afford the means of determining whether *planicosta* deserves a separate name from *Dudressieri*, but after a careful examination I doubt whether the form of *planicosta* can be separated from the young of *Dudressieri*. It will be observed that *planicosta* is a small species, and in many undoubtedly planicostan varieties the characteristic spines of *Dudressieri* are assumed after the specimen attains an unusually large size, so that it becomes impossible to separate them from the young of *Dudressieri*. Several of Sowerby's specimens are unquestionably forms of this species.

There are, however, some extreme forms of *planicosta* laterally very flat and very narrow on the abdomen, for which it may be found convenient to reserve a separate appellation.

My remarks with regard to the affinity of this species with species of the Arietidæ should be more definite. They can apply only to certain parallel or reversionary characteristics which are common to both Arietidæ and Microceras, and not attributable to any direct genetic connection.

Deroceras confusum.

This should be *Ammonites Lohbergensis* Emerson. *Deroceras confusum* Quenst. is very distinct. The figures of Quenst. are not exactly correct. Fig. 8. pl. 72 of "Der Jura" has a hardly perceptible keel connecting some of the abdominal ridges of the original specimen, but absent between others. The whorl is quite round in the young, then acquires the form given in Fig. 8, and then that delineated in Fig. 10. There are, however, still very faint signs of a keel which is entirely lost between the oldest ridges.

Amm. subplanicosta Oppel.

This remarkable form, as seen in the Munich Collection, has young like *biferum*, and in other respects resembles that species, but begins to acquire the planicostan or latæcostan pilæ at a very early age, and in some specimens probably remains similar to *latæcosta* throughout life. There can be but little doubt that it is a latæcostan-like variety of *M. biferum*.

Deroceras desinodum.

This species is not a member of this series at all, but genetically allied with the armatus series.

Androgynoceras hybridum.

This species is very commonly confused with the other forms of Androgynoceras and Liparoceras by all German authors. It is, however, quite readily distinguished by the large size which it attains before acquiring the peculiar tuberculated lateral and divided abdominal pilæ of the group to which it belongs. Sowerby's collection shows that his *Henleyi* was identical with this species, and not with the species which now universally goes by that name.

Androgynoceras appressum.

This is quite a distinct form, but is equal to *Amm. striatus evolutus* Quenst., and to a part of *Amm. hybrida* Oppel, and appears to lead into a peculiar keeled form, also part of *Amm. hybrida* Oppel.

This form becomes almost smooth in the young, and thus resembles *Amm. polymorphus lineatus*, which both Quenstedt and Oppel consider connected with it. I think the resemblance is caused merely by a mode of development which has the same relation to the mode of development in *And. appressum* that the mode of development in *Bechii* has to *Henlyi*. That is, the young are smooth for a long time in both, and both skip the latæcostan stage, but the adults differ in the subsequently developed characteristics of the adult abdomen.

Liparoceras indecisum.

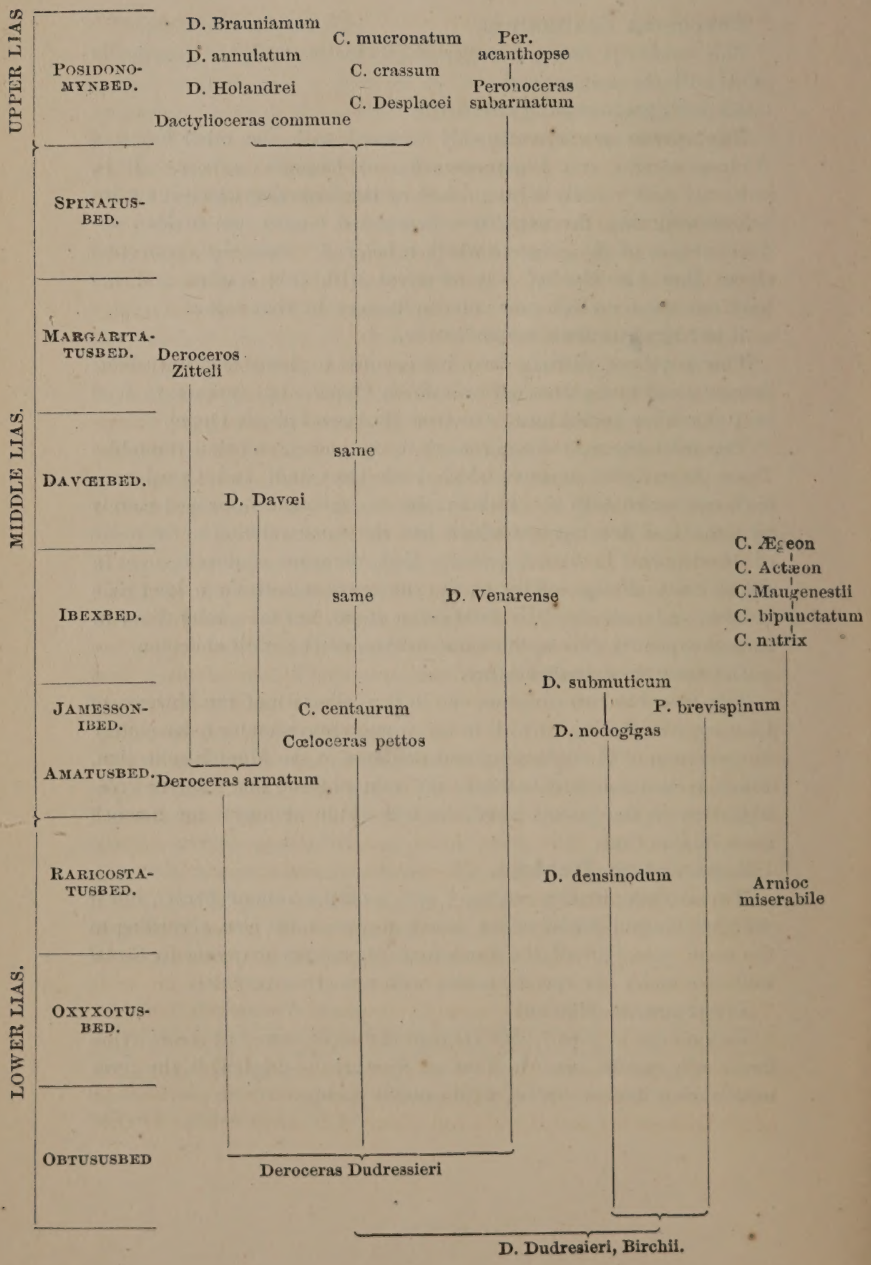
This form has two varieties, one in the collection of the Museum of Comparative Zoölogy, which in the young approximates quite closely to the young of *And. hylrida*, and one form in the Munich collection, which is intermediate between the normal forms and the true *Henleyi*; that is, the young have the latæcostan abdomen for a much more limited time.

Liparoceras Henleyi.

This is undoubtedly, as Oppel states, only a form of *Bechei*, but if we join this and *Bechei* under one name, we must also, according to the same rule, join all the forms from *Microceras latæcosta* to *Bechii* inclusive under one specific name, with numerous varieties.

Liparoceras Bechei.

This occurs in Lias γ with *Henleyi* and *appressum*, but the extreme forms are mostly found in Lias α. Sowerby's original is the form usually identified as *Bechei*, with smooth young.


UPPER LIAS.
MIDDLE LIAS.
LOWER LIAS.
POSIDONOMYNBED.
SPINATUSBED.
MARGARITATUSBED.
DAVŒIBED.
IBEXBED.
JAMESSONIBED.
AMATUSBED.
RARICOSTATUSBED.
OXYXOTUSBED.
OBTUSUSBED
D. Brauniamum
D. annulatum
D. Holandrei
C. mucronatum
C. crassum
C. Desplacei
Per. acanthopse
Peronoceras subarmatum
Dactylioceras commune
Deroceros Zitteli
same
D. Davœi
same
D. Venarense
C. Ægeon
C. Actæon
C. Maugenestii
C. bipunctatum
C. natrix
D. submuticum
P. brevispinum
D. nodogigas
C. centaurum
Cœloceras pettos
Deroceras armatum
D. densinodum
Arnioc miserabile
Deroceras Dudressieri
D. Dudresieri, Birchii.

Appendix to Communication on "The Non Reversionary Series of the Liparoceratidæ," etc.

(Proceedings, Jan. 17th, 1872.)

Deroceras armatum.

I have noted that a well preserved specimen of this species occurs in Prof. Fraas' collection from the Raricostatusbed of the Lower Lias.

Deroceras alternum.

This may be a broad whorled variety of *Deroceras Zitteli* (sp. Oppel), and *Deroceras minatum* Hyatt, Bull. Mus. Comp. Zool., No. 5, p. 94, is probably the typical variety of the same species figured by Oppel in the Mittheilungen, pl. 42.

Both of these forms probably came from the Margaritatusbed, though the latter is labeled Upper Lias, Plateau de Larzac.

D. alternum approximates to Oppel's species in possessing a large abdominal cell, but the lateral cells and lobes are quite different. These differences are not important, however, and *alternum* appears the same as Oppel's species; but whether *minatum* is or not cannot be decided on account of the label referred to above.

Deroceras Davœi.

The *Amm. planarmatus* of Quenstedt appears to be a form of this species. A specimen in the Museum of Stuttgart is much stouter than the ordinary form of *Davœi*, but is more nearly allied to that species than the fragment figured and described by Quenstedt. This has no spines and the pilæ are split into several upon the abdomen according to Quenstedt's description, though the figure shows that they are merely the abdominal remnants of pilæ whose lateral portions have been obliterated. This, the absence of tubercles and the fold-like character of the pilæ, appear to indicate an old age form of *Davœi*. I say this with great doubt, because the septa are slightly different, and I have not seen Quenstedt's original specimen.

Deroceras muticum.

This description includes a broad form, which is the *Deroceras Venarense* (Opp. Spec. Mittheil., pl. 42), and a compressed variety which is named *Amm. muticus* by Boucault. The specimens are from Venarey, and doubtless are merely varieties of Venarensis, but they agree quite closely with D'Orbigny's figure of *Amm. muticus*. Unfortunately the original specimen was not found in D'Orbigny's collection, and I think it would be more consistent with prudence to adopt Quenstedt's and Oppel's conclusion, that *Amm. muticus* D'Orb.

is equal to *Amm. armatus densinodus* Quenst., and give both the above described varieties the name of *Deroceras Venarense*.

Deroceras nodogigas.

This species really belongs to the series of which *Amm. muticus* D'Orb. (*Armatus densinodus* Quenst.) is the first member, and not to this genus at all.

Platypleuroceras brevispina.

This is the *Natrix rotundus* of Quenstedt. Sowerby's original is really a variety of *latæcosta*, as well as the accompanying figure on the same plate, but it seems best to accept Oppel's solution of the difficulty, and cut the knot by applying the name to the *Natrix rotundus* form. *Natrix oblongus* is entirely distinct in every respect. In Prof. Fraas' collection there are two young specimens, undoubtedly belonging to this species from Lias β Balingen.

Amm. natrix oblongus Quenst.

A careful examination of the young in Quenstedt's collection shows them to be very distinct from the young of the preceding. This resembles *Birchii* until a late period, while *Natrix oblongus*, on the other hand, is similar in the younger stages to the adult of *Deroceras densinodum*; the aspect and closeness of the pilæ and truncated spines, the form of the whorls and abdomen are precisely similar. Finally, Quenstedt himself has remarked the similarity of the septa in the adults of both forms. Here, as in many of the neighboring forms, it is very interesting to observe the reversions caused by the reappearance of the planicostan aspect of the abdomen in the adults, accompanied by the loss of the armatoid tubercles. This mode of development unites *desinodum*, *nodogigas* and this species, into one genetic series. The name which should then be adopted is that given by Oppel, *Amm. submuticus*.

Cycloceras natrix.

This species is only separable from *Cycloceras bipunctatum* by the greater stoutness of the whorls and greater rotundity of the abdomen; whether it should be separated from *Natrix rotundus* or not, my material does not permit me to determine.

Cycloceras bipunctatum.

In the collections of Fraas, Quenstedt, and especially in one made by Baron Schwartz, which I saw at Tübingen, it is easy to observe that the old of *bipunctatus* becomes smooth, and possesses the same form as the so-called *Cycl. Masseanum*. A specimen in the collection of Museum of Stuttgart is eleven and a half centimetres in

diameter, but still not so smooth or so advanced in senility as D'Orbigny's figure of a much smaller individual. The young are identical in their characteristics with the more flattened varieties of *Arnioceras miserabile*, which have the pilæ bent forward and of linear aspect.

Amm. maugenestii D'Orb.

This species, as exhibited in Prof. Fraas' collection, shows a young form which at 35 mm. in diameter is precisely similar to the adult of *bipunctatus* at the diameter of 8 to 12 mm. with two rows of spines. The abdomen is also elevated at this early age, though it afterwards flattens slightly, and assumes the planicostan pilæ in some specimens. When 9 mm. in diameter, the specimen referred to above loses its tubercles and begins to become narrower across the abdomen, and at the diameter of 11 to 12 mm. the senile features exactly reproduce the characteristics of the spineless or Masseanus form.

In D'Orbigny's collection it may be seen that there is no real line to be drawn between *Maugenestii* and *bipunctatus* (*Valdani* D'Orb). The single row of spines described by D'Orbigny is confined to a limited number of specimens; the larger number of specimens have two rows of spines. The extreme *Valdani* or *bipunctatus* form is usually thinner, and the septa somewhat different.

Cycloceras Masseanum.

That this is merely the old age of the preceding species, and not a form by itself with adult characteristics, is shown by all the collections I have seen, especially by that of Dr. Schwartz, who first drew my attention to this fact.

Cycloceras Ægæon.

This form is very closely connected to the preceding or Actæon variety of *Maugenestii* by a series of forms in which the old or Masseanus stage is inherited at earlier and earlier periods, until it finally invades the young stages of development. In other words, *C. Ægæon* is the old age type of its series, having no stage corresponding to the adult, but only to the old age of the preceding species.

Peronoceras acanthopsis.

This is evidently only a variety of *subarmatum*, with a broad abdomen.

Peronoceras subarmatum.

As pointed out by Quenstedt, this is identical with the flattened forms named by him *Amm. Bollensis*, and occurring in Lias ε.

Cœloceras pettos.

There are two distinct varieties with numerous intermediate forms. One has large pilæ in the young, and the earlier stages are inseparable from those of *C. centaurus*; the other has smaller and finer pilæ. The development is often distinct when the adults exhibit no perceptible differences. On the other hand, a very broad abdomened typical variety, or a very narrow adult shell, may be produced from young that are precisely similar. In Quenstedt's collection the broad variety is found in the Davœibed, somewhat above the other.

C. pettos and *centaurus*, according to Fraas' and Quenstedt's collection, are found together in the same bed where alone *centaurus* appears in Quenstedt's diagram. This, and numerous intermediate forms, show that they are merely varieties of the same species, though it is convenient to retain their separate names.

Cœloceras Desplacei.

The *Amm. acanthus* D'Orb. is a form of this species which has no tubercles on the cast, very slight ones on the shell, and pilæ very regularly divided. A very fine specimen in D'Orbigny's collection shows the old age. The spines become obsolete, and subsequently they lose their divided pilæ and stretch across the abdomen in parallel lines. At the same time, also, the size of the whorl decreases, the abdomen losing in breadth until the sides are only gibbous near the dorsal line, and then converge rapidly outwards. The breadth of the dorsum also decreases so that a decided tendency to return to a cylindrical smooth form of the whorl is manifested in old age.

Cœloceras crassum.

In D'Orbigny's collection a fine specimen of this form reaches a larger size than any I have seen, nearly 9 mm. In this, also, the tubercles are lost in old age, pilæ become single on the abdomen, and the involution becomes less, as described above for *C. Desplacei*. The *Amm. crassus* of Quenstedt occurs in Lias ε and ζ, and in Fraas' collection there are representatives of this species which have no tubercles; they are from Metzingen.

Cœloceras mucronatum.

This is merely a compressed form of *C. crassum*.

Dactylioceras commune.

This species occurs in the compressed specimens of Lias "ε" of Quenstedt, and in Lias "ζ," as shown by Quenstedt's and Fraas' collections, in company with Holandrei. See also Quenstedt's remarks on *Amm. communis* and *crassus* in "Der Jura," p. 251.

Dactylioceras annulatum.

A form allied to this species appears in Fraas' collection under the name of *Amm. annulatus triplicatus* Quenst., in the Macrocephalibed. This form is precisely intermediate between the true *annulatum* and the *Amm. athleta* of the upper formations, and as stated by him it is not the same as the *annulatus* of the Upper Lias, though very closely allied to it. It is also distinct from *athleta*, and other allied forms of the same group, in which the adults acquire the spines and peculiar outlines of the abdomen and septa of the *athleta* group.